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TAXONOMIC AND GEOGRAPHIC STUDIES IN NORTH AMERICAN FERNS.

III. Pellaea glabella and its Western Segregates.

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As stated recently in a note in the Fern Journal,[1] a further study of the western ferns allied to *Pellaea glabella* Mett. ex Kuhn has convinced me that there are two species occuring in the western states and Canada, closely allied to that well-known northeastern fern, but clearly distinguished from it, and from each other by numerous characters and by their geographical range. One of these, *Pellaea pumila* Rydb., originally described independently by Rydberg from the Black Hills of South Dakota,[2] and by Elias Nelson from Wyoming,[3] occurs along the eastern ranges of the Rocky Mountains from Alberta to Wyoming, the other, my *Pellaea Suksdorfiana*, appears to be confined to the region west of Rocky Mountains, occurring chiefly in the intermontane region, and ranging from British Columbia to

[1] Am. Fern Journ. **11**: 39–40. 1921.
[2] Mem. N. Y. Bot. Garden, **1**: 4. 1900.
[3] Fern Bull. **7**: 30. 1899.

Arizona and New Mexico. It is the purpose of this paper to point out in detail the differences between these three closely related species.

Externally, the three species are fairly easy to distinguish. *P. glabella* is the largest, the fronds measuring up to 25 cm. in length (including the stipe) and, except in obviously depauperate plants, seldom measuring less than 12 cm. In *P. Suksdorfiana* the average length of the frond is 9.5 cm. and it seldom exceeds 12 cm. In one of the Suksdorf specimens listed below the longest frond is 20 cm. long, but this is the only specimen seen which has any fronds over 15 cm. long. *P. pumila* is even more dwarf, the average length of the frond being 6.8 cm., and the longest seen, 14 cm.

In *P. glabella*, except in very young or depauperate plants, the fronds are twice compound. The lowest pair of pinnae, which are the largest, are 3–5-foliolate, the second and third pairs are frequently compound also, and occasionally even pinnae higher up in the frond. The terminal pinnule of a compound pinna is stalked, the lateral pinnules are often over half of the length of the terminal one and closely resemble the small pinnae of the first order which occur towards the tip of the frond. Semi-compound pinnae occur frequently between the completely compound basal, and the simple upper pinnae. In these, the basal lobes, corresponding to the lateral pinnules of compound pinnae, are variously shaped, usually acute, and ¼–½ the length of the central lobe. They are often asymmetrical, with the *posterior* basal lobe better developed than the anterior. Rarely one of the basal lobes is reduced to a mere auricle, and very rarely indeed both basal lobes are so reduced.

P. Suksdorfiana shows much less tendency to form twice compound fronds than *P. glabella* of similar size. Frequently the pinnae are simple throughout, but occasionally the one or two lower pairs of pinnae are 3-

foliolate (very rarely 5-foliolate). In such pinnae the middle pinnule is twice as long as the lateral ones. In semi-compound pinnae the basal pinnules are commonly represented merely by basal auricles, which, in marked contrast to *P. glabella*, are frequently found on both sides of the pinna. Even when compound, the basal pinnae are often smaller than the second pair, and they frequently wither early, so that in many specimens only their petiolules remain. This characteristic tends, of course, to conceal the twice pinnate character of the fronds in many cases.

In *P. pumila* the fronds of the smaller specimens are usually strictly once-pinnate. Those of larger specimens have one or two pairs of nearly compound 2–3-foliolate pinnae. In these the terminal pinnule is not distinctly stalked, but is narrowed at the base, which is confluent with the one or two lateral pinnules, which are less than ½ as long as the terminal one. The *anterior* basal pinnule is often better developed than the posterior, and unilateral (mitten-shaped) pinnae are very common. The basal lobes are very rarely reduced to auricles.

Though somewhat variable, the shape of the simple pinnae is characteristic in each species. In *P. glabella* they are oblong-linear, rarely somewhat lanceolate, obtuse and pseudomucronate[4] or somewhat acute at the apex, and often cordate at the base. The lower ones have stalks about 0.5 mm. long. In *P. Suksdorfiana* they are lanceolate or oblong-lanceolate, obtuse or somewhat acute and rarely pseudomucronate at the apex, and cuneate or narrowed to the base. The lower ones have stalks 1–2 mm. long. In *P. pumila* they are ovate (rarely elliptical, ovate-lanceolate, or lanceolate), obtuse at the apex, and truncate or abruptly cuneate at the base. All are sessile, or the lowest may have very short stalks, less than 0.5 mm. long.

[4] The apparent mucro is formed by the straight tip of the leaflet, while on each side of the tip the margin is abruptly folded in to form part of the indusium.

The leaves of *P. glabella* are very bluish green, with the lower surface distinctly punctate, and bearing a few hair-like scales along the midrib. When mature, the leaves are rather thick, and have very obscure veins, which leave the midrib at a narrow angle, fork about twice, and in the outer part of the leaflet make an angle of about 60° with the midrib. The midrib itself is marked by a slight ridge on the upper side of the leaflet, and is very obscure below. The leaves of *P. Suksdorfiana* are much less blue, the lower surface of the leaflets is somewhat less obviously punctate, and is glabrous. The veins are somewhat conspicuous by transmitted light, leaving the midrib at a narrow angle, forking about twice, and in the outer part of the leaflet making an angle of about 45° with the midrib. The midrib is marked by a slight groove on the upper side of the leaflet, and is somewhat prominent below. The leaves of *P. pumila* are less blue than those of *P. glabella*, the lower surface of the leaflets is not punctate, or at most very obscurely so, and is glabrous. The veins are somewhat more obscure than in *P. Suksdorfiana*, and are about once forked. They leave the midrib at an angle of 30°–45,° and in the outer part of the leaflet make an angle of about 60° with the midrib. The midrib is scarcely visible on the upper side of the leaflet, and is obscurely ridged below.

The whole indusium of *P. glabella* is 0. 7–1. 3 mm. wide, with a nearly entire hyaline margin 0. 2–0. 3 mm. wide. It reaches very close to the tip of the leaflet, or may even extend across the tip from one side of the leaflet to the other. The band of sori is narrow, and is situated on the back of the leaflet close to the angle between the leaf surface and the indusium. Accordingly the sporangia are seldom conspicuous, even in mature fronds. In *P. Suksdorfiana* the indusium is somewhat

narrower, 0. 7–1. 0 mm. wide with a sharply crenulate hyaline edge about 0. 1 mm. wide. It generally ends 0. 5–1. 0 mm. below the tip of the leaflet, though rarely extending to the very tip as in *P. glabella*. The sori cover a band nearly 1 mm. wide, and the sporangia are very conspicuous in mature fronds. In *P. pumila* the indusium is 0. 8–1. 1 mm. wide, with a somewhat crenulate border about 0. 2 mm. wide. The band of sori is somewhat narrower than in *P. Suksdorfiana*, and often extends beyond the point of inflexion of the indusium so that part of the sporangia are borne on the under side of the indusium. They are accordingly better covered and less conspicuous than in *P. Suksdorfiana*.

As between the two western species, perhaps the most clearly diagnostic characters are found in the spores. In an earlier paper[5] I stated that *P. pumila* has only tetrahedral, and *P. Suksdorfiana* only elliptical spores. Examination of further material has proved this statement erroneous, though spores of other form are in each case comparatively rare. The spores of *P. pumila* are much smaller than those of *P. Suksdorfiana* even when comparison is made between spores of similar form. The tetrahedral spores of *P. pumila* vary from 29 × 38 μ–47 × 55 μ, the mean size being 39 × 45. 5 μ; the few elliptical spores are 36 × 47 μ–40 × 55 μ. The tetrahedral spores of *P. Suksdorfiana* measure 50 × 58 μ–61 × 66μ, the much more abundant elliptical spores are 50 × 58μ–64 × 80 μ, with the mean size 58 × 70 μ. While the extremes of the two species approach rather closely, it is to be noted that these extreme measurements apply to only a few scattering spores. In no case has the mean length of the spores in any mount of *P. pumila* exceeded 55 μ, or that of any mount of *P. Suksdorfiana* been less than 65 μ. As regards spore characteristics, *P. glabella* occupies a position somewhat intermediate between the two western species, but more closely resembling *P.*

[5] Am. Fern Journ. **7**: 77. 1917.

Suksdorfiana. The stipes of the three species differ in both external appearance and internal structures. Those of *P. glabella* are dark red-purple, becoming almost black in old age; those of *P. Suksdorfiana* are somewhat lighter in tone, and more reddish brown, while those of *P. pumila* are rather bright chestnut brown, becoming darker in old age, but entirely without any purple tinge. Those of the last mentioned species differ also from the others in their great brittleness, a character which has led to some confusion between this species and *P. Breweri*.

The most characteristic microscopic differences in the stipes are in the epidermal and immediately subjacent layers of cells. The stipes of *P. glabella* have fibrous epidermal cells, which are of rather even size and uniformly very thick-walled (average size in cross-section, 12 × 19 μ, with the lumen 3 μ or less in width). The hypodermal cells are mostly similar, but slightly larger and less thick-walled, and some similar cells occur in the third layer. In *P. Suksdorfiana* the epidermal cells are less uniform, 8 × 11 μ–19 × 22 μ in cross-section, moderately thick-walled with the thickening heaviest on the outer wall, and with the lumen 3.5–5.5 μ wide. The hypodermal cells are somewhat thick-walled, but otherwise resemble the internal parenchyma rather than the epidermis. In *P. pumila* the epidermal cells are nearly circular in cross-section, 9–15 μ in diameter, moderately and uniformly thick-walled with the lumen 4–7 μ wide. The hypodermal layer, with the exception of a few scattered fibrous cells, consists of thin-walled parenchymatous cells.

The vascular bundle of the stipe, and particularly the form of the xylem, is quite distinctive in the three species, though there is enough variation between larger and smaller stipes, and between the proximal and distal parts of the same stipe to confuse somewhat the points of difference. In all the species the xylem con-

sists of a central mass, often cleft along the median plane, and of lateral wings extending outward and towards the ventral side of the stipe. In *P. glabella* these wings are relatively large and widely extended, so that the xylem bundle has in cross-section the outline of a very flat V. The whole vascular bundle is somewhat reniform in cross-section, or merely flattened on the ventral side. In *P. Suksdorfiana* the wings of the xylem are somewhat shorter, and at first extend horizontally, then curve sharply towards the ventral side of the stipe, and may even be completely inflexed at the tip. The whole vascular bundle has a distinctly reniform cross-section. In *P. pumila* the wings of the xylem are still shorter, and directed towards the ventral side of the stipe, the xylem mass is very compact, and the whole vascular bundle is nearly circular in cross-section.

In my earlier paper I cited the specimens of the two western species which are in the Gray Herbarium. The following specimens from the National Herbarium (N) and the Herbarium of the University of Minnesota (M) have been examined in the preparation of the present paper:

Pellaea pumila: SOUTH DAKOTA; Bull Springs west of Custer, *P. A. Rydberg*, no. 1191 (N); Deadwood, crevices in white rocks, *C. R. Ball*, no. 1688 (N).

WYOMING: Laramie Hills, Albany Co., *A. and E. Nelson* no. 6837 (N); Loomis Creek, Natrona Co., dry cracks in cliffs, *Leslie N. Gooding* no. 183 (N two sheets); Mammouth Hot Springs, Yellowstone Park, dry cracks in cliffs alt. 6000 ft., *F. H. Burglehaus* (M two sheets, and N).

MONTANA: Bozeman, limestone cliffs 5000 ft., *J. W. Blankinship* no. 638 (N); Belt Mts., *R. S. Williams* no. 241 (N).

ALBERTA: Banff, limestone cliff at base of Tunnel Mt. *F. K. Butters* (M).

Pellaea Suksdorfiana: ARIZONA: San Francisco Mts., 9000 ft., *D. T. MacDougal* (M); Jacob Lake, Kaibab

National Forest, alt. 8000 ft., *D. F. Korstian and F. S. Baker* (N).

UTAH: In crevices of rocks near Kanab, *Ivar Tidestrom* no. 2284 (N); Armstrong and White Canyons near the Natural Bridges, alt. 1600–1800 m., *P. A. Rydberg and A. O. Garrett* no. 9421 (N); Three Lakes, Kane Co., alt. 1800 m. *W. W. Eggleston* no. 10243 (N).

WASHINGTON: Klickitat Co., on cliffs near the Columbia, *W. N. Suksdorf* no. 2083 (M and N, two sheets); cliffs east of Bingen, Klickitat Co., *W. N. Suksdorf coll., ex herb. F. L. Pickett* no. 561 (N), a different collection from the above, but apparently from the same locality.

BRITISH COLUMBIA: Carbonate Draw [Upper Columbia Valley] *Edw. R. Heacock in Shaw's Selkirk Flora*, no. 272 (M).

While a large number of specimens of *Pellaea glabella* have been examined, they all fall within the geographical range delimited in my former paper on that species.

UNIVERSITY OF MINNESOTA.

A List of Ferns found in New Hampshire.

CHARLES S. AND WILLIAM F. LEWIS.

These ferns were found during the summers of 1916 and 1918 in four localities: a. The northeastern corner of Lake Winnepesaukee near Melvin Village, 1916. This includes Mt. Shaw. b. The neighborhood of North Woodstock and the mountains near that village, 1916. c. The neighborhood of Whitefield, 1918. d. The Presidential Range, including especially Mt. Washington approached from the Castellated Trail and King's Ravine, 1918: also Owl's Head, Cherry Mt. The names are in the order of the seventh edition of